

Yield Trial Of 5 Single Cross Hybrids From Gamma Ray Radiation Inbred Lines Of Maize

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ABSTRACT

Maize is the second most important major food source commodity following rice. Maize is also highly used for animal feed and industrial raw materials due to high carbohydrate and protein content in its kernels. Import of maize for animal feed is increasing from year to year. Efforts to improve production can be done by developing high yielding hybrid varieties. A study is aimed to evaluate the yield potential of 5 single cross maize hybrids of mutant gamma radiation inbred lines. The genotypes tested were hybrids CT5, CT8, CT9, CT13, CT14 and BISI-18, one commercial hybrid as a control. The results showed that on the perspective of leaf number, leaf length, leaf width, cob diameter and length, BISI-18 was superior to all hybrids evaluated. However, the newly developed hybrids were earlier to flower and mature than BISI-18. Although BISI-18 also showed highest number of kernel per ear and grain yield, hybrid CT9 and CT13 were not significantly different from those of the commercial hybrid. It needs further field trial at different agro-ecosystems to explore growth and yield of those new developed hybrids.

Key words: maize, hybrid, yield trial

INTRODUCTION

Maize (*Zea mays* L.) is the second most important cereal food crop in Indonesia, following rice, and also being used as animal feed and raw material in industry as it contains high carbohydrate and protein (Dinas Perindustrian dan Perdagangan, 2012). Maize demand is increasing, being predicted to reach 22.08 million ton in 2015, some of which is fulfilled from import. National maize production fluctuated in recent years, from 18.32 million ton in 2010, decreasing to become 17.64 million ton in 2011, and regrowth to 19.39 million ton in 2012 (BPS, 2013), but still did not meet the increasing demand. Increasing maize production could be reached partly through the use of maize hybrids with high yielding potential and good quality as their production potential are higher than those of open varieties or composit varieties (Robi'in, 2009; Balai Penelitian Serealia, 2012). Therefore, breeding program is important to continuously creating new hybrids.

Superior hybrids are characterized by their high heterosis value and high yielding potential. An experiment by Yustiana et al. (2013) demonstrated that an high general combining ability of hybrid line produced good characters of cob length, 1000-seed weight, cob weight per plot and yield potential at least in one location. We have found five hybrid genotypes which have higher yield potential based on seed weight per cob than S6 line (Mujianto 2013). For release as a cultivars, these genotypes needs to be tested for its yield potential.

Testing yield potential is an important step in a breeding program as environment plays an crucial role which interact with genetic to realize crop potential (Sari *et al.*, 2013; Hijria *et al.*, 2012). In this testing, potential hybrid cultivars are compared with established current hybrid cultivars, which subsequently selected for obtaining the best cultivars (Rahmah dan Aswidinoor, 2013). An experiment was aimed to evaluate the yield potential of 5 single cross maize hybrids of mutant gamma radiation inbred lines, compared with commercial hybrid BISI-18 as a control.

METHOD

An experiment was conducted in Kandang Limun Village, Bengkulu City from August to November 2015. In this experiment, five potential cultivars, i.e. CT5, CT8, CT9, CT13, CT14 and a commercial hybrid control BISI-18, were tested using a randomized complete block design with three replications. An experimental unit was composed of 42 plants.

Soil was cleaned from weed and previous plants. Top soil was cultivated at 20-cm depth and being leveraged. Plots was made at size of 5,25 m x 3,6 m, with drainage ditch made at 1 m width and 20 cm depth. Planting distance were made 75 cm x 60 cm, and planting depth was 2,5 cm. Each planting hole was placed one seed and 5-10 carbofuran 3%. First fertilization used Urea, SP36 dan KCl at 150 kg ha⁻¹, 200 kg ha⁻¹, and 150 kg ha⁻¹, respectively, placed at 5 cm from planting holes. Second fertilization used only urea at 150 kg ha⁻¹. Weed were controlled manually at 3 weeks after planting, at time of soil mounting; whereas, pesticides being used were 2 ml/l Deltamethrin 25 g/l and 2 g/l Mankoze 800 G.

Cobs were harvested when they were dry, being hard when opened, and black layer being formed at proximal end of the seeds. Seeds was full and shining with no marks when pressed with nail (Adisarwanto dan Widyastuti, 2009). Observations were conducted for sampled plants in each effective plot. Observed data consisted of qualitative and quantitative variables based of high yielding maize varieties description (Balai Penelitian Serealia, 2012).

Data were analyzed by using analysis of variance to determine the differences of the variables tested. For variables in which cultivars demonstrating significant difference, a Duncan's Multiple Range Test (DMRT) at level <5% was used to separate the cultivars.

RESULTS AND DISCUSSION

Plant Growth, Flowering and Harvest Date

Based on the data collected in this experiment, analysis of variance results of growth variables demonstrated that leaf number, leaf length, leaf width, age of male and female flower emergence, and harvest date were significantly different between genotypes. Whereas, the other variables showed no significant difference among genotypes.

Results of this experiment showed that from all genotypes tested in this experiment, control commercial hybrid BISI-18 had the highest value for leaf number, leaf length, and leaf width, significantly greater than those of all other tested hybrids (Table 1). The leaf number of BISI-18 had 1-2 more strands than the other hybrids. BISI-18 also showed the longest leaf length (90,1 cm), significantly longer than those of the others; whereas CT9 had the shortest leaf (66.8 cm). The widest leaf also found in BISI-18 (10.7 cm), significantly wider than those of the others (7.8 – 8.7cm).

Table 1. Average number of leaves, leaf length, leaf width, age male flowering and female flowering dates of five maize hybrids

Hybrid	Leaves number (strands)	Length leaves (cm)	Width leaves (cm)	Male flower emergence (day)	Female flower emergence (day)	Harvest Date (day)
CT 5	11,67 b	82,11 b	8,73 b	56,33 b	61,33 b	104,33 b
CT 8	11,60 b	73,32 cd	8,72 b	56,33 b	62,67 b	106,33 b
CT 9	11,13 b	66,75 d	8,27 b	50,33 c	61,00 b	104,33 b
CT 13	11,57 b	74,48 bc	7,82 b	56,33 b	61,67 b	104,33 b
CT 14	11,13 b	79,89 bc	7,81 b	53,33 bc	60,33 b	104,33 b
BISI-18	13,20 a	90,13 a	10,70 a	67,00 a	70,33 a	125,67 a

Notes : Values in the same column followed by the same letter show no significant difference according to DMRT at 5%

Efficient use of sunlight through photosynthesis led to higher crop yields, in this case maize kernels produced. Therefore, number of leaves, leaf length and leaf width are very important character

because leaves plays an important role in the process of photosynthesis. The the greater the number of leaves and leaf area, the greater the amount of assimilates resulting from the photosynthesis process if unimpeded light and CO₂ (Rustikawati *et al.*, 2010). For this reason, at planting distance of 70 cm x 60 cm in this experiment, BISI-18 was superior to the tested hybrids. However, the tested hybrid CT9, which had significantly shorter leaf (67 cm) as compared with BISI-18, might be tested further in narrower distance, such as 70 cm x 40 cm and shorted crop duration to facilitate better photosynthesis efficiency.

In the case of flowering time, tested hybrids had significantly shorter juvenile period than BISI-18 (Table 1). Male flower of BISI-18 emerged at 67 days after planting, being 11 to 17 days after CT5, CT8, CT13, CT14 and CT9, the last hybrid showing the most precocious male flowering (at day 50). In case of female flower, the tested hybrids flowered at day 60 to 63, significantly 8 to 10 days faster ($P < 0.05$) than BISI-18 (at day 70.3 days after planting). In addition, harvesting time in tested hybrids (CT5, CT8, CT9, CT13, and CT14) were 104 to 106 day after planting, 19 to 21 days earlier than in BISI-18 (125 days after planting). These show a good indication that the tested hybrids were potential for improvement of short period production character. Kartahadimaja and Syuriani (2013) reported that maize inbred lines of PL.503 PL.408 have short life to harvest, but producing lower 100-seed weight than other inbred strains. In addition, this short life to harvest character enable the tested hybrids for planting especially when cropping season is shorter. This is in accordance with those stated by Sari *et al.* (2013) that early flowering is superior character of a plant.

Cob Growth and Seed Production

Among the hybrid genotypes tested, this experiment showed that dry seed weight, number of seed rows per cob and weight of 100 seeds were not significantly different. In contrast, cob diameter, number of seeds per cob, dry seed weight per plot, and cob length were significantly varied among genotypes.

Cop growth variables of BISI-18, including cop diameter (65 mm), open cob diameter (54 mm), and cob length (23 cm), were significantly greater than those of the tested hybrids, ranged 58 – 60 mm, 45 – 50 cm, and 17 – 19 mm, respectively (Table 2).

Table 2. Cob growth and yield of hybrid maize

Hybrid	Harvest date (day)		Cob diameter (mm)		Open cob diameter (mm)		Cob length (cm)		Seed number per cob		Dry seed weight (kg ha ⁻¹)	
CT 5	104,33	b	58,22	b	45,05	c	17,20	b	408,87	c	3007,41	b
CT 8	106,33	b	58,32	b	47,56	bc	18,17	b	476,33	bc	2810,51	b
CT 9	104,33	b	60,38	b	49,81	b	17,93	b	554,36	ab	3987,41	ab
CT 13	104,33	b	56,82	b	49,91	b	19,03	b	528,53	ab	3501,49	ab
CT 14	104,33	b	58,05	b	44,77	c	17,73	b	503,60	ab	3187,69	b
BISI-18	125,67	a	65,18	a	54,49	a	23,43	a	565,50	a	4751,77	a

Notes : Values in the same column followed by the same letter show no significant difference according to DMRT at 5%

There were variations in open cob diameter among the tested hybrids, in which CT9 and CT13 showed bigger cob than CT5 and CT14. Cob length and number of seeds per cob are generally closely linked with dry maize seed yield. Commercial BISI-18 showed cob length of 23.4 cm, significantly longer than those of the tested hybrids. In term of number of seeds per cob, CT9 (528), CT13 (554) and CT14 (503) were not significantly different with BISI-18 (566); however, CT8 (476) and CT5 (409) lower seed number than those of hybrid control BISI-18.

Lastly, based on seed yield, commercial control BISI-18 had the highest dry seed yield (4752 kg ha⁻¹), but not significantly different with CT13 (3501 kg ha⁻¹) and CT9 (3987 kg ha⁻¹), with gap of 765 kg ha⁻¹ (Table 2). CT8 demonstrated the lowest dry seed yield per plot (2811 kg ha⁻¹), albeit being not significantly different from those of CT5 and CT14. For these reasons, CT9 can be chose as a potential for further development.

Similar results in examining yield potential of maize was reported by Kartahadimadja (2010), who demonstrated that seed yield of a single cross hybrid maize tested was higher than those of Pioneer-23. Research results by Mubarakkan *et al.* (2012) demonstrated that of 12 maize hybrids grown in conditions of low input levels, their adaptation and the performance are almost the same in terms of plant height, stem diameter, days to flowering, age cob-hair protrusion, ear height, time of harvest, diameter cob without husk, cob length, number of seed rows per cob, seed number per line, 100-seed weight, fresh cob weight and dry seed yields.

The test results on several variables presented in Table 1 and Table 2 indicate that data values among variables are interrelated. A hybrid that has greater diameter of cob, cob length, and the high value of number seeds also has high yields and heavier weight of dry beans per plot. Robi'in (2009) also found that cob length and diameter are closely related to seed portion of cob. If the average cob length of varieties are longer than those of other varieties, these varieties are likely to have a higher yield than the other varieties.

Increased seed weight allegedly closely linked to the amount of photosynthate partitioned into the cob. The greater the photosynthate partitioned or allocated to the cob, the greater the accumulation of food reserves are translocated to the seeds thus increasing seed weight. In the contrary, the lesser photosynthate partitioned or allocated to the cob, the lesser does food reserves translocated to the seeds; hence seed weight was reduced (Praktikta *et al.*, 2013).

CONCLUSIONS

Based on the results of this study, we concluded that maize hybrid CT-9 produced high dry seed weight, the second highest following those of commercial control BISI-18 with difference in dry seed weight per plot about 765 ha⁻¹. However, hybrid CT9 had an advantage of a short crop that can be harvested at the age of 104 days, 21 days faster than those of BISI-18, showing promise for short season conditions.

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